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THE IMPACT OF NASA'S ACTIVITIES ON EDUCATION

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In a statement before the Select Committee on Government Research of the U.S. House of Representatives, Lloyd V. Berkner describes our current national economic and social perspective as follows:

"Our nation is in the midst of a social and economic revolution of a magnitude unprecedented in the history of society. The roots of this revolution are nourished by the power of today's science from which is derived an equally powerful technology. The characteristics of this revolution are derived from the rapid convergence of a wide variety of industries of an entirely new variety founded upon scientific innovation, industries not devoted to the traditional production of the primitive necessities of life--food, clothing, and shelter--but industries directed toward enlarging man's capabilities in his environment, extending his horizons, and better fitting him to command his environment."

The revolution of which Berkner speaks has been in progress since the industrial revolution of the last century but has proceeded at an explosive pace during the past three decades. The obvious impact on the average citizen has been made by practical developments in his food supply, his home, his clothing, his health, and in the broad fields of energy, communications, and transportation. More progress has been

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made in the last half-century in these areas than in all of the centuries before in the history of man.

The success of agricultural research in improving the productivity of our farms; the development of new methods of food preservation, food processing, food packaging, supermarkets; and the remarkable progress in knowledge of requirements for human nutrition -- all have contributed to the revolution which brings within view the technological possibilities of freedom from hunger for all.

Our homes have been transformed from rude shelters from the elements to more luxurious palaces than those possessed by the kings of the last century. Modern developments in materials, many of them created for the purpose; new forms and greater amounts of energy applied with automatic controls for air-conditioning in hot or cold weather, for lighting, for the household tasks of dish-washing, clothes-washing, cleaning, and for mere conveniences such as can-opening, tooth-brushing, shaving, and hair-drying; and the telephone -- these have appeared within the past half-century.

The wonders of chemistry have transformed our clothing from the drab, coarse fibers or skins of the average man of the last century to the colorful and varied wardrobe of today. The products of the cotton plant and the silkworm have been supplemented and often replaced by the synthetic products of the chemical laboratory.

Throughout all of our activities much of the change which has occurred depended on the availability of sources of energy to supplement

the work which could be accomplished by human muscular effort. The form in which the energy became available was also a major factor. The industrial civilization with which we began this century was based on the energy of coal and the steam engine, which converted a part of the heat energy obtained by burning coal to mechanical power in a rotating shaft. The automotive age was based on gasoline, another petroleum product, and the internal combustion engine. Revolutionary developments came with the development of the electrical generator and motor, which made possible the transmission of power over considerable distances. At present we are in the midst of the wider application of nuclear power and the experimental study of direct solar power and of fuel cells for certain specialized purposes. The net effect of the development of energy sources has been to provide the average man with the equivalent of hundreds of slaves at small cost and to enable him to perform modifications of his physical environment which would otherwise be impossible.

The story of communications progress from telephone to radio to television is well known to all. The breaking of the barriers of distance through developments in transportation is also an often-told story. In my boyhood on the farm a round trip to the nearest town 12 miles away was an all-day affair. Today an automobile on the super-highways may travel easily half a thousand miles. By air Europe is now only six or seven hours away, and in a few years by supersonic transport only two hours.

The most advanced technological development of our time came to the notice of the world on October 4, 1957, when man sent into space the first artificial satellite of the earth, the Soviet Sputnik. That first venture into space could have been ours--we had the ability to do it but not the foresight or the determination. This event was followed by the establishment in our country of the National Aeronautics and Space Administration, which came into existence officially on October 1, 1958. These events and the events of the intervening six years have had a profound impact on human affairs throughout the world, and especially within our own country. Repercussions have been felt in science, industry, education, government, law, ethics, and religion. No area of human activity or thought has escaped. The toys of our children, the ambitions of our young men and women, the fortunes of industrialists, the daily tasks of diplomats, the careers of military officers, the pronouncements of high church officials -- all have reflected the all-pervading influence of the age of space exploration.

We shall be concerned this afternoon with the challenge of space exploration to educators, particularly with the impact of NASA's activities on education. It must be appreciated at the start that NASA does not have a major public responsibility for the promotion and advancement of education as such. Nevertheless, NASA feels a great responsibility to organize and conduct space exploration in such a manner as to utilize the best resources of the country in such a way as to strengthen rather than weaken our free institutions, including

our schools and universities. NASA activities do have an important impact on education. Under the National Aeronautics and Space Act of 1958, one of NASA's functions is to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." In carrying out this function, we cooperate with many public and private agencies, including the U.S. Office of Education, State boards of education, colleges and universities, and the public media.

The exploration of space is a continuation of the geographical exploration by man of unknown areas of the earth from the days of the Phoenician mariners three thousand years ago. The New World, the polar regions, the depths of the ocean, the limits of the atmosphere -- have each in turn been the temporary goal. Space is the new frontier.

Ralph J. Cordiner gave an interesting analysis of this new frontier in his lecture in the "Peacetime Uses of Space" series of the University of California:

"At this stage, the new frontier does not look very promising to the profit-minded business man, or to the tax-minded citizen." . . .

"Every new frontier presents the same problem of vision and risk. . . . Leif Ericson discovered America 500 years before Columbus, but apparently the Vikings did not have the vision to see anything worthwhile on that vast, empty continent, and so history waited for another half millenium." . . .

"When a new frontier is opened, the new territory always looks

vast, empty, hostile, and unrewarding. It is always dangerous to go there, and almost impossible to live there in loneliness and peril. The technological capacities of the time are always taxed to the utmost in dealing with the new environment." . . .

"It takes an immense effort of imagination for the citizens to see beyond these initial difficulties of opening a new frontier. No one would pretend to foresee all the economic, political, social, and cultural changes that will follow in the wake of the first exploratory shots in space, any more than the people in the days of Columbus could foresee the Twentieth Century world. But such an effort at prophetic imagination is what is required of us as citizens, so that we will not, like Leif Ericson, leave the making of the future to others."

We have as a nation accepted the challenge of the new frontier, and this year are spending a little more than five billion dollars on the exploration of space for peaceful purposes. This represents an expenditure of approximately 50 cents per week by each of the 200 million inhabitants of our country. We do not have time to discuss the what, how, and why of the space program, with which you are somewhat familiar from the daily press and from other talks that you may have heard.

In this age of space exploration, one of the experiences that all of us must expect is to be continually confronted with new ideas. I hope that our modern school boards are not like that Ohio school board of 1828 who responded to a request for use of the schoolhouse to hold a debate by saying: "You are welcome to use the schoolroom to debate

all proper questions, but such things as railroads and telegraphs are impossibilities and rank infidelity. There is nothing in the word of God about them. If God had designed that his intelligent creatures should travel at the frightful speed of 15 miles per hour by steam, He would have foretold it through his holy prophets. It is a device of Satan to lead immortal souls down to hell."

The frightful speed is now much greater. We talk about earth orbital speeds of 17,500 miles per hour and return speeds from the moon of 25,000 miles per hour.

Astronomical distances, long known to us, strike us with new force as we realize that we may traverse them. Our nearest neighbor, the moon, is about 240,000 miles away, a little under 10 hours at 25,000 miles per hour. Mars is 49 million miles distant at nearest approach, or a little over 80 days. However, the nearest star is 25 million million miles away, or more than 100,000 years at 25,000 miles per hour. We have much to learn before we are ready to consider going to the stars.

The rapid and explosive growth of science and technology which has brought us to the space age has been spawning new ideas for some time. The coming of the Sputnik merely increased the pressure to accelerate the tempo of changes in education which began during the last war. The revaluation of engineering curricula which began just after World War II has extended to the entire curriculum throughout all levels of our educational system, and particularly to the teaching of science.

This has led to projects for revision of the course material in mathematics, physics, chemistry, and biology in which scientists and educators are working in collaboration. The accelerated tempo of science and technology has highlighted the long lead time between the new information obtained in the laboratories and its incorporation in textbooks and other course materials. A healthy interest of scientists in improved teaching and a renewed appreciation by educators of the importance of up-to-date course content as well as effective teaching methods are leading toward impressive progress.

There is a significant new interest in quality--for the conservation of intellectual ability wherever it is found among our people. Thus in the present aftermath of the beginning of space exploration, we find widespread demands for recognizing various levels of intellectual ability, for adapting the content of the curriculum, the teaching method, and the rate of progress to the capacities of individuals, particularly to those above average in ability.

Finally, because of the character of the society in which we live, we are realizing the need for the teaching of general courses in science and engineering as a part of the cultural heritage of every educated person, and in the continuation of education throughout adult life. In our country most of our political leaders have been trained in law or business administration; few have the background to deal intelligently with the scientific and engineering implications of many questions of public policy. By contrast, we have found that in the U.S.S.R., where

law and business are monopolies of the government, science is the preferred field for the general education of those who aspire to leadership. It is not suggested that we undertake such a radical change in our educational practices, but there is need for better knowledge of science and engineering by our leaders, the differences between these two important activities, and their respective roles in the world of today.

NASA has a special relationship to universities. For operations, production, and most development, we rely upon industry. But for the basic research upon which to build a complex new technology, we rely mainly upon universities. Without the full partnership of the universities, NASA would be unable to do the job of exploring the new frontier of space.

Universities are the only knowledge-creating institutions that produce more trained people than they consume. As a prime user of trained people, NASA has an obligation to carry on its work in such a manner as to create the necessary new knowledge and produce more trained people as well. Both of these results can be accomplished simultaneously by working within the existing university structure rather than fostering activities which pull the university researcher away from the teaching environment.

For many years the Government has used the resources of the universities for research through the so-called project method. NASA will continue to place demands for direct assistance on university

scientists where the work is of such a nature that it is best performed by the university rather than by industry. However, a more intimate partnership is necessary and desirable. Thus in addition to direct project support, NASA initiated in FY 1962 a program of enlarged scope for utilizing more fully the abilities of our universities in the space program. The program is planned to meet the needs of NASA and of the university and includes the encouragement of the establishment of interdisciplinary groups for research in broad areas to be supported by grants; the support of the training of people in the field of space science and technology through grants; and in certain cases to provide research facilities.

These three components--research, facilities, and training--are complementary and their relative magnitudes have been balanced to ensure the most efficient use of the Nation's academic capabilities and resources.

Many of the problems encountered in the space program require an interdisciplinary approach demanding the concerted and cooperative efforts of biologists, geologists, physicists, chemists, electronic specialists, metallurgists, engineers, economists, sociologists, and many others. The universities are the only institutions having the ability to bring to bear on our problems such a variety of skills. We have therefore given encouragement to the consolidation of related research projects into unified multi-disciplinary activities, initiation of new investigations to fill existing gaps, and participation of

promising new groups with high potential. The multi-disciplinary research activities allow able scholars in diverse disciplines to work together on the broad problems which frequently resist piecemeal attack. As a byproduct, some universities are gaining an increased appreciation of the intellectual influence they can exert toward the creation of a favorable climate for progress and growth in the economic environment of their regions as a result of their space-related efforts.

Development of such groups not only gives the immediate yield of new talent but provides new incentives for scientists to remain there and resist the excessive drift of skilled manpower from growing institutions to other universities with highly publicized programs or to industry. It also makes it unnecessary for young scientists to leave universities which attract them for many reasons and in which they are needed but which offer no opportunity for them to participate in currently exciting and challenging space-oriented research.

At many institutions heavily engaged in research in response to NASA's requirements, work is being impeded by inadequacy or complete lack of laboratory space. Accordingly, we have made research facilities available to these institutions for graduate research.

In the spring of 1962, after extensive consultation with leaders in the university community and with other governmental agencies, NASA initiated its pre-doctoral training program. The main element involves three-year pre-doctoral training opportunities for selected graduate students at qualified universities offering Ph.D. degrees in

space-related areas. NASA selects participating universities on the basis of proposals which they submit. Individual trainees are selected by senior members of the faculty who know the capabilities of the students, who will probably supervise their research training, and who in many cases are directly engaged in research activities supported by NASA. During 1963, 786 individuals were in training at 88 universities, and this year the number is being increased to 1,071 at 131 universities.

In the programs which we have been discussing, the focus has been on graduate education and research, making direct contributions to NASA but carried out in such a way as to strengthen the university. The NASA function involved is that of the exploration of space. We now turn to activities connected with "the widest practicable and appropriate dissemination of information concerning its /NASA's/ activities and results thereof." Here it is clear that it is not practical for NASA to meet all the desires of those who wish information. It is our plan to cooperate in the support of pilot activities co-sponsored by agencies having primary responsibility and to develop resource materials such as publications, films, et cetera, which may be helpful. These activities, conducted by the Educational and Services Division of NASA, are probably of most interest to you, since these activities have a direct effect upon adult education.

Some of these educational information activities, with an emphasis upon reaching teachers at the secondary level, have been in cooperation

with colleges and universities, through their extension divisions, and have provided the opportunity for participants to gain an understanding of NASA's activities in space exploration. For example, space-related in-service extension courses were co-sponsored last year by NASA and Washington State University, the University of Bridgeport, Connecticut, and the State Teachers Colleges in Gorham and Farmington, Maine. Others ongoing during this fiscal year include co-sponsorship with Ohio State University; Pratt Institute, New York; Wayne State University, Detroit, Michigan; State Teachers College, Long Beach, California; University of South Florida, Tampa, Florida; University of North Carolina; Chipola Junior College; and the Maine State Teachers Colleges in Aroostook, Fort Kent, and Washington.

In all of these situations, NASA contributes information on space science and technology, derived from our activities in space; a few resource people as guest lecturers; scientific, technical, and general purpose films; publications of many types; field trips to NASA field installations, where practicable; and special programs such as the space lecture-demonstrations by Spacemobile lecturers who are former teachers specially trained by NASA. NASA participation is generally dependent upon the share of the load carried by the sponsoring organization and upon the assistance requested.

One program of particular interest to this group is an adult education program called "Mankind and Space" offered this past spring by the Rhode Island Department of Education, in cooperation with NASA,

to 120 laymen representing a cross section of the community of Providence, Rhode Island. The purpose of the program was to provide the participating adults with an opportunity to keep abreast of scientific and technological developments taking place in a rapidly changing world, recognizing that space exploration is a dynamic force affecting society and inducing many of the changes. The program was a pilot or experimental project and proved out one effective method of satisfying the tremendous amount of adult interest in space activities.

The course consisted of ten weeks of weekly two-hour sessions. The outline, materials of study, discussions, and techniques used were prepared in the form of a syllabus which will be available for distribution to other State departments of education and, upon request, to others concerned with adult education. Preliminary evaluations indicate that this program may well serve as one pattern useful nationally in adult education.

The NASA Spacemobile program has been an effective device in our educational-information program. The Spacemobile is a panel truck, filled with spacecraft and launch vehicle models, basic scientific experimental apparatus, demonstration devices, and a number of visual aids. This is utilized by lecturers, former teachers, in presentations to school assemblies and various gathering of adults. It basically answers the questions: What is a satellite? How is it put into orbit? What does it do? And what are the major NASA programs in space exploration? Last fiscal year this program reached a total audience of about

four million. The approximate breakdown of types of audiences is: high schools 62%; elementary and junior high schools 20%; colleges and universities 10%; and general adult programs 8%. In addition, the 15 units operating in the 50 States and Puerto Rico during 1963 made 68 television appearances to an estimated audience of 15 million, of which it is estimated three million were adults. On request from the concerned governments, and through the U.S. Department of State and the U.S. Information Agency, six Spacemobile units operated on a shared-cost basis in Brazil, Argentina, Venezuela, Mexico, Nigeria, France, Germany, India, and the Malagasy Republic.

We have an educational television and radio program which reaches effectively many adults as well as students. This produces programs about space projects for broadcasting on both commercial and non-commercial stations. We work closely with the Nation's 89 educational television stations, providing them assistance as required in the preparation of space-related programs for both in-school and adult audiences. Our weekly "Space Study" radio program, a five-minute weekly report on space science, is broadcast on many commercial radio stations. It is difficult to assess how many people, on campus and off campus, are reached by both the TV and radio media, but it is a tremendously large audience.

Many films listed in our catalogues are requested by the adult general public from our headquarters and field offices and research centers. During the first half of FY 64 a conservatively estimated audience of over 100,000 persons in every corner of the country viewed NASA films.

Our educational publications program is responsive to the demand for information about space exploration and the mission of NASA by students, teachers, and other members of the public whose interest is lively but who lack technical background. These publications, accordingly, are in nontechnical language for use by laymen.

These include booklets such as Space, the New Frontier, which describes the broad field of NASA space activity, and others such as 1, 2, 3 . . . and the Moon!, describing Project Mercury, Gemini, and Apollo, which treat specific parts of our program in more depth. Seventeen up-to-date NASA-developed booklets and folders are now available from the Superintendent of Documents of the U.S. Government Printing Office.

A series of publications that is especially aimed at aiding teachers is NASA FACTS. This consists of descriptions of specific projects such as Ranger, Mariner, Explorer Satellites, et cetera.

Appropriate materials about NASA programs appearing in magazines and newspapers are occasionally produced as reprints (with permission of the originators) and made available to the public.

Materials originated by NASA and published at the Government Printing Office are initially distributed to a key list of educators and others, and then are available from NASA in single copies to persons requesting them. The publications are also sold by the Superintendent of Documents, and copies in bulk are available from the Superintendent of Documents.

These are some of the ways by which NASA attempts to disseminate information about its activities, and to make an appropriate contribution to the educational process and to public understanding of the scientific and technical age in which we are all immersed. The President's Science Advisory Committee, in its 1959 report on "Education for the Age of Science," emphasized that:

"In the conditions of modern life the rule is absolute: The race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. . . . We must have trained specialists in many fields. Even then we would not be successful if, having such specialists, the American people were merely to applaud and reward them for their contributions while still thinking of them as useful strangers, dimly understood and more feared than admired. . . . We must also cultivate a widespread dedication to and respect for learning in all fields, and a deep understanding between the public and the experts."

In summary, the task of exploring space is one which will stretch the muscles and brains of man; it will test to the utmost our powers of enlisting the cooperation of every element of our society as well as of teams of scientists and engineers. The task is of such a magnitude that it is a challenge to the resources of nations and their will to cooperate. The progress already made gives us a glimpse of the future potentialities. Educators as well as all the rest of us must reexamine

our habits of thought and action. We must use our insight and vision to guide our present-day decisions to prepare our successors for the coming developments in the Age of Space Exploration.

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